Climate Change, Human Health, and the Future of the Developing World

Kristie L. Ebi, Ph.D., MPH

Renewing the Campus
9 October 2009
Seasonal Patterns of Salmonella, 1992-2000

Fleury et al. 2006
Climate: What You Expect

Weather: What you get
Climate

• Variability
  – Short-term fluctuations around the average weather
  – Includes ENSO (El Nino - Southern Oscillation)

• Change
  – Operates over decades or longer
  -- General Circulation Models (GCMs) / Earth System Models (ESMs)
    • Scenarios, NOT predictions
    • Downscaling / spatial issues
Surface

Troposphere

°C per decade

Difference (°C) from 1961-1990

Estimated actual global mean temperatures (°C)

Annual mean

Smoothed series

5-95% decadal error bars

<table>
<thead>
<tr>
<th>Period</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.177±0.052</td>
</tr>
<tr>
<td>50</td>
<td>0.128±0.026</td>
</tr>
<tr>
<td>100</td>
<td>0.074±0.018</td>
</tr>
<tr>
<td>150</td>
<td>0.045±0.012</td>
</tr>
</tbody>
</table>

IPCC 2007
Pathways by Which Climate Change May Affect Human Health

IPCC 2007
Multiple Factors Affect Climate-Sensitive Health Outcomes

• Biophysical factors
  – Baseline climate
  – Elevation
  – Natural resources (i.e. water bodies)

• Biological sensitivity
  – Concomitant diseases
  – Acquired immunity
  – Genetic factors

• Socioeconomic status
IPCC AR4 Health Impacts of Climate Change

- Emerging evidence of climate change impacts:
  - Altered distribution of some vectors
  - Altered seasonal distribution of some pollen species
  - Increased risk of heatwave deaths
### Direction and Magnitude of Climate Change Health Impacts

<table>
<thead>
<tr>
<th>Negative Impact</th>
<th>Positive Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very High Confidence</strong></td>
<td></td>
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<tr>
<td><em>Malaria: Contraction and expansion,</em></td>
<td></td>
</tr>
<tr>
<td><em>changes in transmission season</em></td>
<td></td>
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<tr>
<td><strong>High Confidence</strong></td>
<td></td>
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<tr>
<td><em>Increase in malnutrition</em></td>
<td></td>
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<tr>
<td><em>Increase in the number of people suffering</em></td>
<td></td>
</tr>
<tr>
<td><em>from deaths, disease and injuries</em></td>
<td></td>
</tr>
<tr>
<td><em>from extreme weather events</em></td>
<td></td>
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<tr>
<td><em>Increase in the frequency of cardio-respiratory diseases from changes in air quality</em></td>
<td></td>
</tr>
<tr>
<td><em>Change in the range of infectious disease vectors</em></td>
<td></td>
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<tr>
<td><em>Reduction of cold-related deaths</em></td>
<td></td>
</tr>
<tr>
<td><strong>Medium Confidence</strong></td>
<td></td>
</tr>
<tr>
<td><em>Increase in the burden of diarrheal diseases</em></td>
<td></td>
</tr>
</tbody>
</table>
Annual deaths:
- Diarrheal diseases = 2 million deaths
- Malaria = 1 million

Malnutrition is an underlying cause of 50% of the 10.5 million annual childhood deaths

Pitcher et al. 2008
Diarrheal Disease

- Diarrheal diseases kill nearly 5,000 children every day
  - It is the 2nd leading killer of children
- Worldwide, 12% of childhood mortality is due to diarrheal disease
  - In many low-income countries, up to 26% of childhood mortality is due to diarrheal disease
- 88% of childhood diarrheal disease attributed to unsafe water, inadequate sanitation, and poor hygiene
**Temperature and Enteric Disease**

- **RR of Salmonella** increased by 1.2% per degree above - 10°C
- **RR of Campylobacter** increased by 2.2% (4.5% in Newfoundland) per degree above - 10°C
- **RR of E. coli** increased by 6.0% per degree above - 10°C

*Fleury et al. 2006*
• 2-fold increase in odds of waterborne disease outbreak if rainfall > 93rd percentile

Distribution of rainfall over year

Least rainy

Most rainy

Thomas et al. 2006
Relationship Between Water Availability at the Household Level in Jordan and Diarrheal Disease

![Graph showing the relationship between water consumption and incidence of diarrheal disease.]

- First scenario: "Business as usual Cases at 0.41 (2004)
- Second scenario: "reduce incidence to 0.27" (2010)
- Third scenario: "reduce incidence to 0.21" (2015)

Health and Environment Linkages Initiative, Jordan Country Project, 2005
2025

Fuzzy Climate Suitability 2025

- Cities
- No Data

Harare
Bulawayo

Ebi et al. 2005
2050

Ebi et al. 2005
Climate Change-Attributable Malaria Deaths in Botswana, Niger, and Nigeria, SRES A1B

Tol et al. 2007
- Cholera
- Meningococcal meningitis
- Dengue/dengue haemorrhagic fever
- Chikungunya
- African trypanosomiasis
- Yellow fever
- Japanese and St. Louis encephalitis
- Rift Valley fever
- Leishmaniasis
- West Nile virus
- Ross River virus and Murray Valley encephalitis
Sensitivity of Rice Yields to Temperature Change

(e) Rice, mid- to high-latitude

(f) Rice, low latitude

Easterling et al. 2007
Projected Changes in Length of Growing Season, 2050

ECHam4, B1

ECHam4, B2

> 20% loss
5-20% loss
No change
5-20% gain
>20% gain

International Livestock Research Institute, 2006
Climate Change Impacts in 2030 under 750 ppm CO$_2$ Scenario (thousands of cases)

Estimated costs to treat the climate change-related cases = $3,992 to $12,603 million

<table>
<thead>
<tr>
<th></th>
<th>Diarrhea</th>
<th>Malnutrition</th>
<th>Malaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>4,513,981</td>
<td>46,352</td>
<td>408,227</td>
</tr>
<tr>
<td>Climate change impacts</td>
<td>131,980</td>
<td>4,673</td>
<td>21,787</td>
</tr>
<tr>
<td>% increase</td>
<td>3%</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Responding to climate change involves an iterative risk management process that includes both adaptation and mitigation and takes into account climate change damages, co-benefits, sustainability, equity and attitudes to risk.
Prerequisites for Action

• Awareness that a problem exists
• Understanding of the causes
• A sense that the problem matters
• The capability to influence
• The political will to deal with the problem
Climate Change Is About Choice

IPCC 2007
AT THE GATES.
Our safety depends upon official vigilance.
Thank You